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Teaching Tips

Using Concept Maps to Assess Students' Understanding of Information Systems

Lee A. Freeman
School of Management, The University of Michigan - Dearborn
Dearborn, MI 48128, USA
lefreema@umd.umich.edu

and

Andrew Urbaczewski
School of Accounting, IS, and Business Law, Washington State University
Pullman, WA 99164, USA
andrewu@wsu.edu

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1. INTRODUCTION

As IS educators, we are tasked with preparing students with a broad education in business and computer information systems, but measuring their total knowledge can be difficult. While the students are often tested in each of their classes on the topics and concepts for that particular class, there is rarely a unifying measure of their knowledge gained over the entire period of time. Of course, faculty could give these graduating students a comprehensive exam to see what the students do remember from their previous courses, but this seems impractical and highly susceptible to measurement errors producing unreliable data.

An alternative approach to this type of traditional knowledge assessment at a conceptual level is the use of mental models, specifically concept maps or concept webs (Markham et al. 1994). Concept maps provide a visual representation of conceptual and relationship knowledge of main concepts and major sub-topics within a particular domain (Hoover and Rabideau 1995). Concept maps consist of nodes that represent the concepts and arcs that connect the nodes and represent the presence of a relationship. Concept maps look like a spider's web consisting of many concepts or nodes connected to each other by lines signifying the presence of relationships. See Figure 1 for a sample concept map. Concept maps have been used for many years as a means for communicating knowledge in fields such as education, biology, history, mathematics, engineering, computer science, and communications (Williams 1995).

When a student creates a visual representation of his/her cognitive conceptualization of the field of information systems in a concept map, viewers of that map are able to see and understand how that student views and organizes the field of information systems within his/her mind. The concepts and their relationships to each other are represented visually, showing the items that the student knows, their relationships, and the items that the student does not feel are important enough to be included, or possibly forgot to include.

Concept maps are typically assessed by comparing them to an expert's map in either quantitative or qualitative forms. Comparisons of the students' maps to the maps of experts provide information regarding how much is remembered from the previous courses and whether the concepts that are remembered and included are done so

"correctly" according to the experts. Finally, if there are major differences between the student maps and the expert maps, changes may be necessitated in the teaching of the class(es) so that the students have closer conceptualizations to the experts. Other assessment techniques include counting the number of concepts and the number of relationships to determine the degree of complexity. These concept maps could potentially be used as an overall assessment of the department's teaching efficacy or, more simply, as a view into the minds of the students.

2. TEACHING MODEL

The five part framework from Joyce and Weil (1980) for communicating an instructional model will be used to explain the nature of the teaching model being described. 1. Syntax – in the first phase, students identify concepts and relationships and in the second phase, students create their concept map. 2. Social System – the students are the center of activity; there is a small amount of structure imposed by the teacher. 3. Principles of Reaction – the teacher should remain outside of the activity and should not influence the students. 4. Support System – no other resources or conditions are necessary, though students may use whatever resources they wish. 5. Instructional and Nurturant Effects – the direct effects achieved through this teaching model are an awareness of alternative assessment methods, an improvement in concept-building strategies, a greater awareness of the topic domain, and a greater understanding of the relationships between the concepts; the indirect effects are an awareness of alternative perspectives, an awareness of expert vs. novice mental models, and a tolerance for ambiguity. The above teaching model is specifically applied in the situation described below.

3. SAMPLE APPLICATION

Students in the senior-level, capstone undergraduate IS course were given an assignment of creating concept maps of their conceptual understanding of the field of Information Systems. They were required to create their concept map in a graphical format, but were not restricted as to the method, the tool, or the physical display size of their map. As part of the assignment, their maps had to include at least 150 distinct concepts or items and the appropriate relationships between concepts (according to their own understanding and view). A short training exercise was provided during the third class session of the course. The assignment was due on the last day of the course, allowing students five weeks to complete the assignment using whatever resources and material they felt necessary, except for each other. The first author was the instructor for this class and answered all questions from the students regarding the assignment. The actual assignment can be viewed at **http://www.urbaczewski.com/papers/conceptmaps/conceptmapassignment.doc**.

For reasons of brevity and focus, it was determined that only a subset of the students' concept maps, that which relates to Telecommunications, would be analyzed at first. A working paper of this analysis is available at **http://www.urbaczewski.com/papers/conceptmaps/telecommworkingpaper.doc**.

Comments are welcome and should be directed to either author of this teaching tip.

4. DISCUSSION

In contrast with most traditional methods of assessment, this assignment was found to be fun for the students. Many students commented that they learned a lot from the assignment and that they found the assignment to be enjoyable, especially since it was so unlike any other assignment they were doing at the time. These comments of enjoyment and general positive feelings toward concept mapping match those found by Taber (1994). Granted, this method may not be appropriate to replace other assessment methods, but that will depend on the specific situation and the type of knowledge to be assessed.

Figures 2 and 3 show the student composite map, created as a compilation of individual maps, and the expert map created by the instructor who taught the students the specific area of reference. While more detailed results and analyses are contained in the working paper mentioned above, it should be noted that only 11 concepts and 3 relationships were a part of both the student composite map and the expert map (out of approximately 30 concepts and 34 relationships on each). In addition to the apparent lack of overlap between the student composite and the expert maps in terms of actual concepts and relationships, a qualitative assessment of the overlap provides additional support for the lack of an overlap. In looking at the two maps (Figures 2 and 3), the student composite map is concerned with very low-level concepts and concepts that the students are likely to encounter on a regular basis, either in their daily routine or in other courses. The expert's map contains concepts that are much more high-level and concern the overall make-up of telecommunications and networks.

This particular assignment was completely an individual assignment. The creation of concept maps in group settings is a separate issue, though this would have been an interesting exercise and may therefore be appropriate for future assessments. Similarly, there were no

comparisons within individuals over time. Research suggests that concept maps indeed show the differences between novices and experts within a field (Markham et al. 1994; Wallace and Mintzes 1990), so future uses of concept maps within the classroom could analyze the differences in concept maps from individuals drawn at different points in time.

Finally, this was only one application of concept maps for the assessment of students' knowledge. The use of concept maps as assessment tools has many options – individual versus group maps; single instances versus snapshots over time; single topic domains versus more general domains; and qualitative versus quantitative assessments of the maps themselves. Potential applications of concept mapping as a tool for knowledge assessment exist both in academia and in industry. This application of concept maps is a step towards a better understanding of their use and their usefulness as assessment tools.

6. REFERENCES

Hoover, J.J. and D.K. Rabideau, [1995], "Semantic Webs and Study Skills," Intervention in School and Clinic (30:5), pp. 292-296.

Joyce, B. and M. Weil [1980], Models of Teaching, 2/e. Prentice-Hall, Englewood Cliffs, NJ.

Markham, K.M., J.J. Mintzes, and M.G. Jones, [1994], "The Concept Map as a Research and Evaluation Tool: Further Evidence of Validity," Journal of Research in Science Teaching, vol 31(1), pp. 91-101.

Taber, K.S, 1994, "Student Reaction on Being Introduced to Concept Mapping," Physics Education, vol 29(5), pp. 276-281.

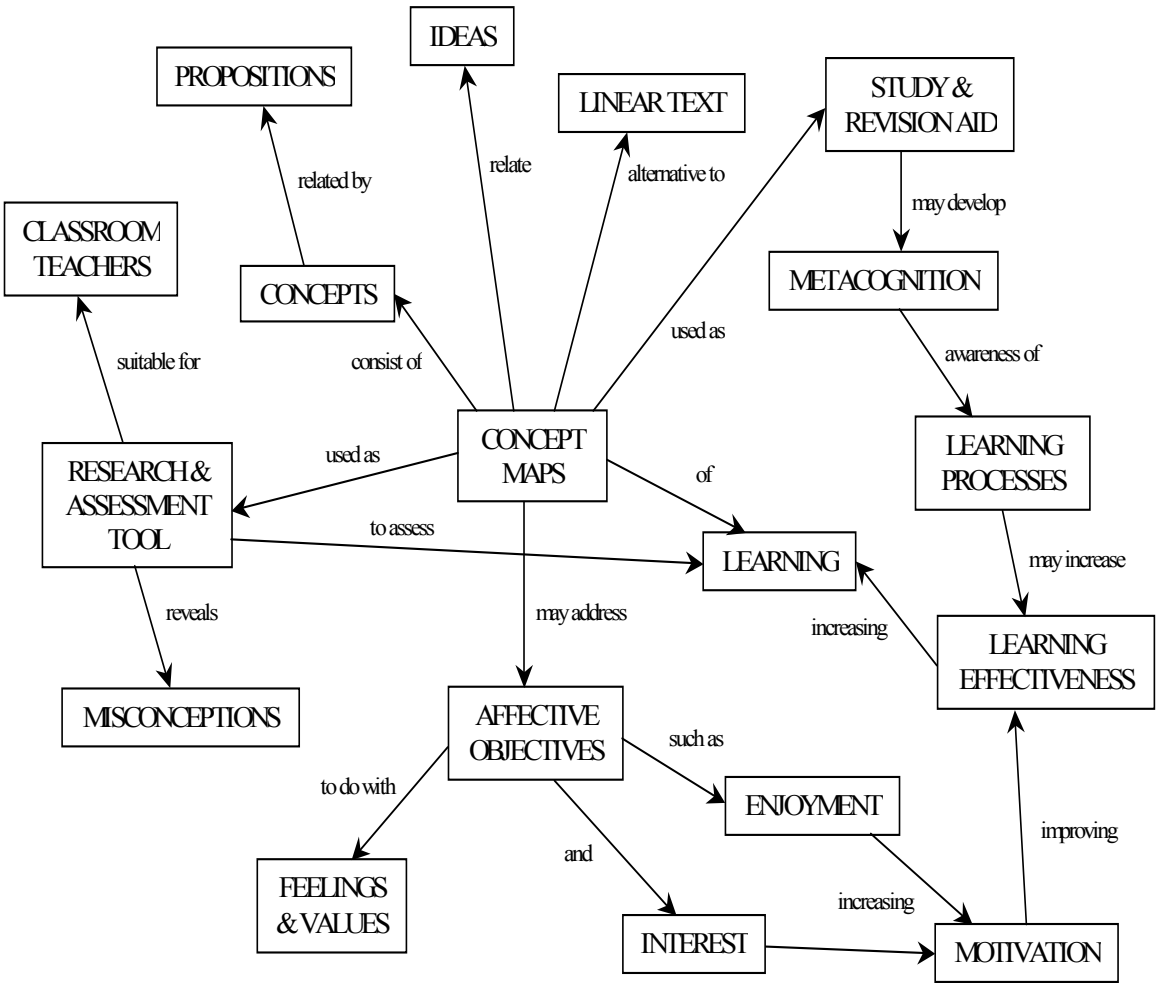
Wallace, J.D. and J.J. Mintzes, [1990], "The Concept Map as a Research Tool: Exploring Conceptual Change in Biology," Journal of Research in Science Teaching, vol 27(10), pp. 1033-1052.

Williams, C.G, [1995], "Concept Maps as Research Tools in Mathematics," Annual Meeting of the American Educational Research Association, San Francisco, CA.

Lee A. Freeman is an assistant professor of MIS at The University of Michigan – Dearborn. He has a B.A. from The University of Chicago, and he received both his M.B.A. and Ph.D. in Information Systems from Indiana University, the latter in 2000. His primary research interests include the conceptualization and use of information systems knowledge, electronic commerce, and systems analysis and design. He has published in *MIS Quarterly*, *Information Systems Frontiers*, *Failures and Lessons Learned in Information Technology Management*, and the *Handbook of IS Management*, among others.

Andrew Urbaczewski is an Assistant Professor of MIS at Washington State University in Pullman, WA. He holds a B.S. with honors from the University of Tennessee, a MBA from West Virginia University, and a Ph.D. from Indiana University. His teaching interests include telecommunications and electronic commerce, while his research interests include electronic commerce, electronic monitoring, and information systems education.

Figure 1. Sample Concept Map



A general concept map showing the mapping of "concept maps" according to Taber. Note that the links are displayed as arrows showing the direction of the link, a convention not always used by others. Source: Taber (1994).

Figure 2. Student Composite Concept Map

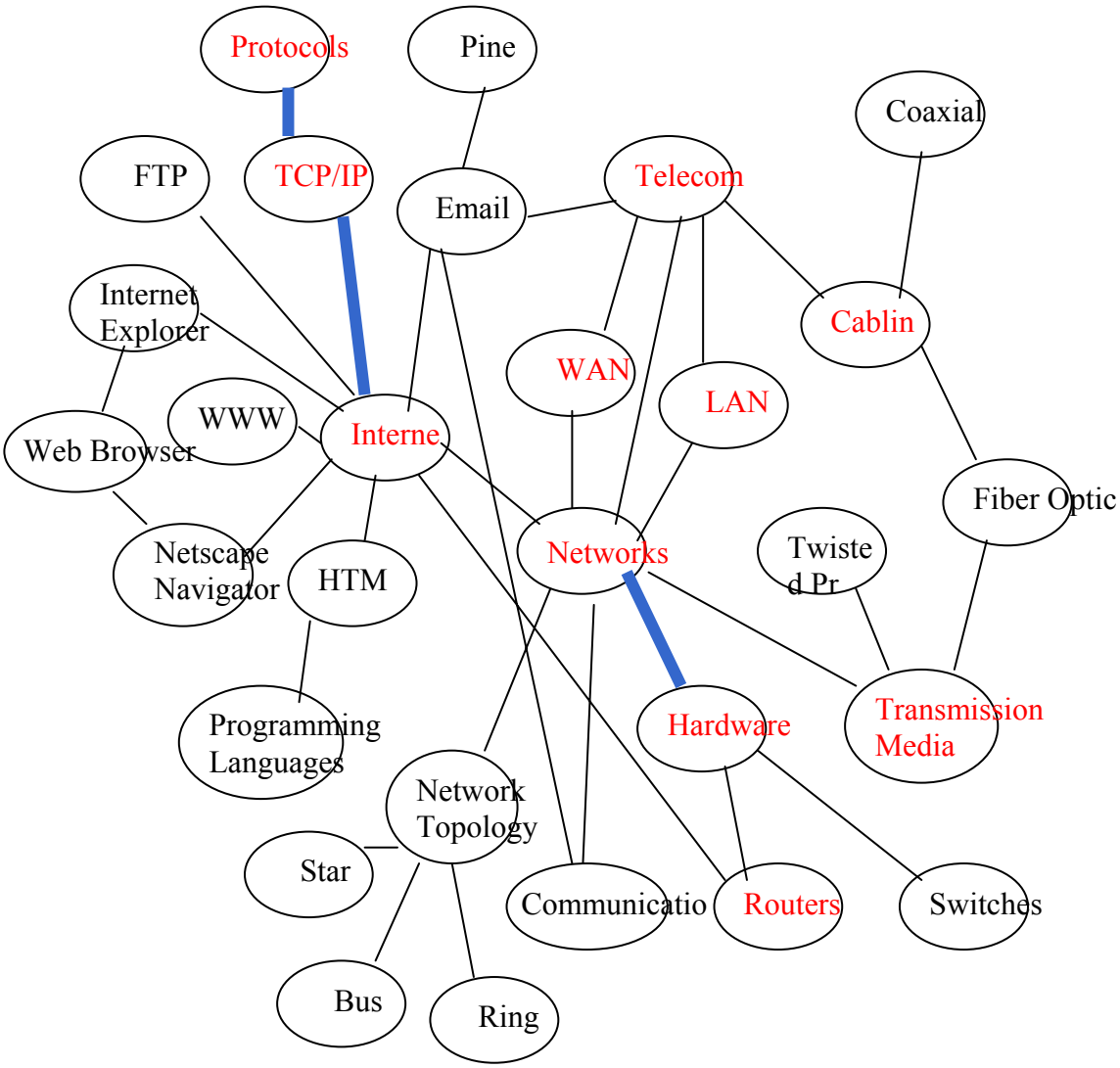
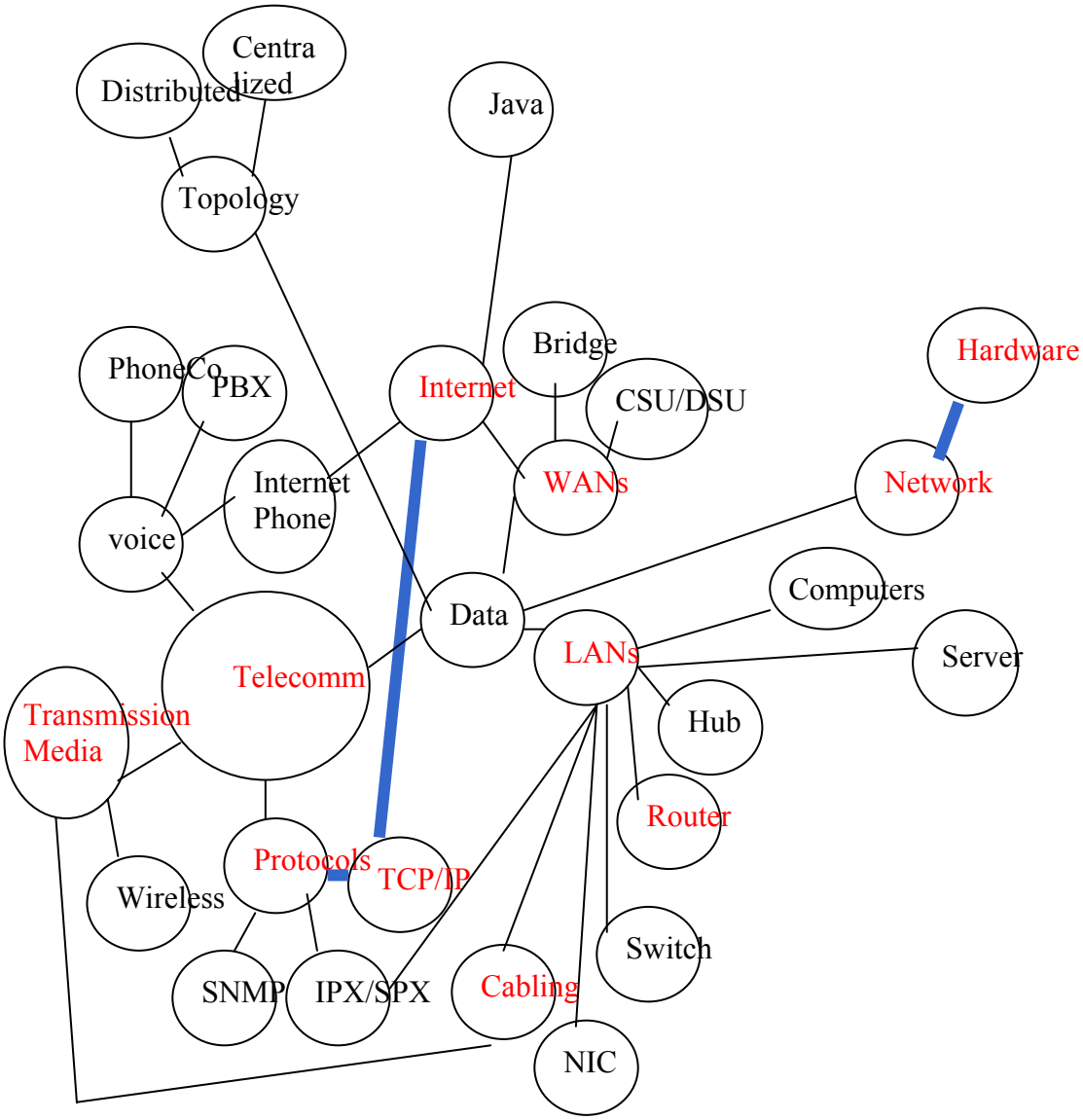


Figure 3. Expert's Concept Map



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